Tube Pneumonostomy for Thoracotomy Reject Crippling Bullous Emphysema

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In 1929 Lillienthal[1] had already reported the alleviation of symptoms of a tension cyst by temporary tube drainage with the use of a one-way valve. Intracavitary suction drainage for the treatment of tuberculous tension cavities was described by Monaldi in July, 1938.[2] Head and Avery[3] reported gratifying results with intracavitary suction drainage in the treatment of emphysematous bullae and blebs in 1949. Subsequently the choice treatment for symptomatic bullous emphysema has been thoracotomy and excision or obliteration of the bullae.[4-7] During the last ten to fifteen years, intracavitary suction drainage has rarely been used, if at all, in the treatment of symptomatic bullous emphysema.

In most instances when the respiratory insufficiency is marked and thoracotomy is considered hazardous, the patient is classified as one for whom nothing more can be done. This is the type of case which is of particular interest to me.

At this time I should like to state that the literature confuses the issue because no distinction is made between bullous and diffuse obstructive emphysema.[8] I believe that these are two different conditions. A patient with bullous emphysema without diffuse obstructive emphysema is usually an acceptable candidate for thoracotomy. The cause of this condition is not known. On the other hand, diffuse obstructive emphysema can usually be traced back to exposure to pulmonary irritants such as smoking, particularly cigaret smoking, industrial exposure to irritants, or chronic recurring specific or nonspecific infections. Some of these patients with both bullous and diffuse obstructive emphysema will be too risky to be thoracotomized. For these respiratory cripples the intracavitary suction drainage or tube pneumonostomy is the only chance for decisive help.

Technic

The procedure is performed under local, infiltration anesthesia in two stages. First an approximately 1 or 1.5-inch length of an overlying rib is removed by an extrapleural, subperiosteal technic. Great care is exercised not to puncture the underlying parietal pleura. The wound is then packed with washed iodoform gauze. Usually the irritation caused by this packing is enough to produce fusion of the parietal pleura and the underlying wall of the bulla within eight to fourteen days. When this fusion is achieved, a small stab wound is made within the fused area. Through this opening a number 22 or 24 rubber catheter is inserted. The soft tissues around the catheter are approximated with interrupted sutures, and the tube is attached to an underwater drainage bottle. The underwater drainage bottle is attached to a suction unit at all times. Within seven to thirty-three days the bullous wall becomes approximated and adhered. When this is accomplished, the tube is removed. By this time the neighboring part of the lung compressed by the sizable bulla is reexpanded, and the respiratory capacity of the patient is noticeably increased. The clinical improvement is usually obvious and substantiated by respiratory and blood-gas studies.

Case records

Case 1. A forty-nine-year-old woman complained of progressive exertional dyspnea, cough, and mucus expectoration for at least six years prior to February, 1968, when she was seen by us for the first time. At that time even talking made her dyspneic. She had to stop and rest ten to fifteen times while getting dressed because of exertional dyspnea. It usually took her about one and one-half hours to get dressed. She had syncopes two to three times a week during the last year. She had carbon dioxide narcosis in November 1963, December, 1963, and May, 1964. She had pneumonia at the ages of four and one-half, seventeen thirty-four, and forty years. She also suffered from poly arthritis since the age of twenty years. She received uninterrupted steroid therapy for fourteen years. She used an intermittent positive pressure breathing apparatus at home since 1964. In addition to steroids she used bronchodilators, antibiotics, mucomyst, and so on. Nothing helped her any longer.

She started to smoke at the age of eighteen years and smoked two and one-half to three packs of cigarets daily. She stopped smoking in November, 1967, four months before coming to us.

She was cyanotic and had difficulty in breathing while talking. She also had marked retraction of the lower intercostal spaces. Auscultation revealed hardly audible breath sounds. No rales or wheezes were heard. Heart sounds were distant. Her liver was two fingerbreadths below the costal margin. Chest x-ray films showed overdistended lungs with bullae occupying the upper two thirds of each lung field (Fig. 1). Respiratory studies substantiated the diagnosis of diffuse obstructive emphysema in addition to bilateral bullous emphysema (Tables I to III).

She submitted to a series of 16 SSTBD (selective systematic tracheobronchial drainages) between March 1 and March 22, 1968.[9] Her condition improved, but the improvement could not be maintained without

FIGURE 1 Case 1. (A and B) Preoperative posteroanterior and lateral chest roentgenograms showing overdistended lungs. Upper two thirds of both lungs occupied by large bullae.

daily aspirations of her tracheobronchial tree (Tables I to III). For this reason, on March 28, 1968, tracheal fenestration was performed.[10] Her condition improved further but not enough to be rehabilitated or even to endure thoracotomy and excision of the bullae (Tables I to III). Therefore, it was decided to do staged bilateral tube pneumonostomies.

On May 19, 1969, she underwent right first-stage tube pneumonostomy under 1 per cent procaine infiltration anesthesia. Eight days later, on May 27, she

TABLE I. Case 1: Serial respiratory studies—16 SSTBD

Procedure and Dates of Studies	Vital Capacity (Ml.) Actual	Per Cent	Timed Vital Capacity (Per Cent) 1 Sec.	2 Sec.	3 Sec.
Before therapy					
2/27/68	1,267	45	38	55	66
After therapy					
3/25/68	1,429	50	42	57	66
Tracheal fenestration					
3/28/68					
5/9/68	1,650	58	35	47	56
5/15/69	925	33	38	54	67
Two-staged right tube pneumonostomy					
5/19/69					
5/27/69					
8/27/69	1,510	54	51	71	84
Two-staged left tube pneumonostomy					
10/13/69					
10/22/69					
11/26/69	2,419	87	45	66	76
Tube pneumonostomy for abscess of right upper lobe					
2/27/70					
7/10/70	2,744	98	37	53	62
6/1/71	2,760	98	42	60	72
12/21/71	2,723	98	40	60	70

TABLE II. Case 1: Serial respiratory studies—16 SSTBD*

Procedure and Dates of Study	MEFR L./Min.	MM-EFR L./Sec.	MBC Act.	MBC Per Cent	TLC Act.	TLC Per Cent	RV Act.	RV Per Cent	RV/TLC Ratio
Before therapy									
2/27/68	7.8	0.13	13.0	17	6,991	189	5,318	613	76.1
After therapy									
3/25/68	9.9	0.13	16.7	21	6,200	167	4,193	483	67.6
Tracheal fenestration									
3/28/68	...	...	...	...	...	...	...	...	...
5/9/68	16.6	0.14	22.9	30	6,901	186	4,977	574	72.1
5/15/69	19.2	0.22	17.1	22	6,614	163	5,291	424	80.0
Two-staged right tube pneumonostomy									
5/19/69	...	...	...	...	...	...	...	...	...
5/27/69	...	...	...	...	...	...	...	...	...
8/27/69	17.4	0.26	20.2	26	6,143	152	3,966	318	64.6
Two-staged left tube pneumonostomy									
10/13/69	...	...	...	...	...	...	...	...	...
10/22/69	...	...	...	...	...	...	...	...	...
11/26/69	52.7	0.35	32.5	41	6,094	151	3,554	286	58.3
Tube pneumonostomy for abscess of right upper lobe									
2/27/70	...	...	...	...	...	...	...	...	...
7/10/70	38.0	...	33.0	42	5,603	138	2,758	241	49.2
6/7/71	58.0	0.47	36.0	46	5,690	140	2,820	247	49.6
12/21/71	35.0	0.35	36.0	46	5,244	130	2,456	198	46.8

* Key: MEFR = maximal expiratory flow rate; MMEFR = ; Act. = actual; MBC = maximal breathing capacity; TLC = total lung capacity; RV = residual volume.

TABLE III. Case 1: Serial arterial blood gas studies—16 SSTBD*

Procedure and Dates of Studies	Arterial Blood Gas Studies pH	PAO_2 (Mm. Hg)	$PACO_2$ (Mm. Hg)
Before therapy			
2/27/68	7.386	73.0	45.7
After therapy			
3/25/68	7.398	88.1	47.8
Tracheal fenestration			
3/28/68	...	...	...
5/9/68	7.453	78.0	55.3
5/15/69	7.345	...	50.0
Two-staged right tube pneumonostomy			
5/19/69	...	...	...
5/27/69	...	...	...
8/27/69	7.380	63.9	39.6
Two-staged left tube pneumonostomy			
10/13/69	...	...	...
10/22/69	...	...	...
11/26/69	7.450	80.0	37.0
Tube pneumonostomy for abscess of right upper lobe			
2/27/70	...	...	...
12/7/71	7.420	96.9	36.2

* Key: PAO_2 = arterial oxygen pressure; $PACO_2$ = arterial carbon dioxide pressure.

underwent right second-stage tube pneumonostomy. The pneumonostomy tube was attached to an underwater drainage setup. The latter was then attached to a suction unit. The suction was maintained for thirty-three days before the pneumonostomy tube was removed on June 29, 1969. Her exercise tolerance increased noticeably. This was also substantiated by the follow-up respiratory and arterial blood gas studies. On October 13, 1969, left first-stage tube pneumonostomy was performed. Nine days later, on October 22, she underwent left second-stage tube pneumonostomy. The pneumonostomy tube was attached to an underwater drainage setup. The latter was then attached to a suction unit. The suction was maintained for seventeen days before the pneumonostomy tube was removed on November 8, 1969. Chest x-ray films showed increased bronchovascular markings bilaterally (Fig. 2). Her exercise tolerance increased sufficiently to allow her to return to full-time work. Follow-up respiratory studies substantiated the clinical improvement (Tables I to III).

Because of her polyarthritis she was put on oxyphenbutazone (Tandearil) by her local physician which led to tarry stools and bleeding from her bronchial tree. This probably played an important role in her developing a right upper-lobe abscess. For this reason, about three months after her discharge, she was readmitted to the hospital on February 13, 1970. On February 27, 1970, right-tube pneumonostomy was performed for the abscess. This led to a good recovery.

She has been working full time since May, 1970. She was also weaned from steroids by August, 1970. The full rehabilitation of this respiratory cripple would not have been possible without tube pneumonostomies.

Case 2. When first seen by me on March 14, 1969, this sixty-two-year-old woman gave a history of progressive exertional dyspnea for more than ten years. During the last year her condition become considerably worse. She became dyspneic even if she just talked, ate, combed her hair, or walked only two steps. She noticed ankle swelling on and off for the last year.

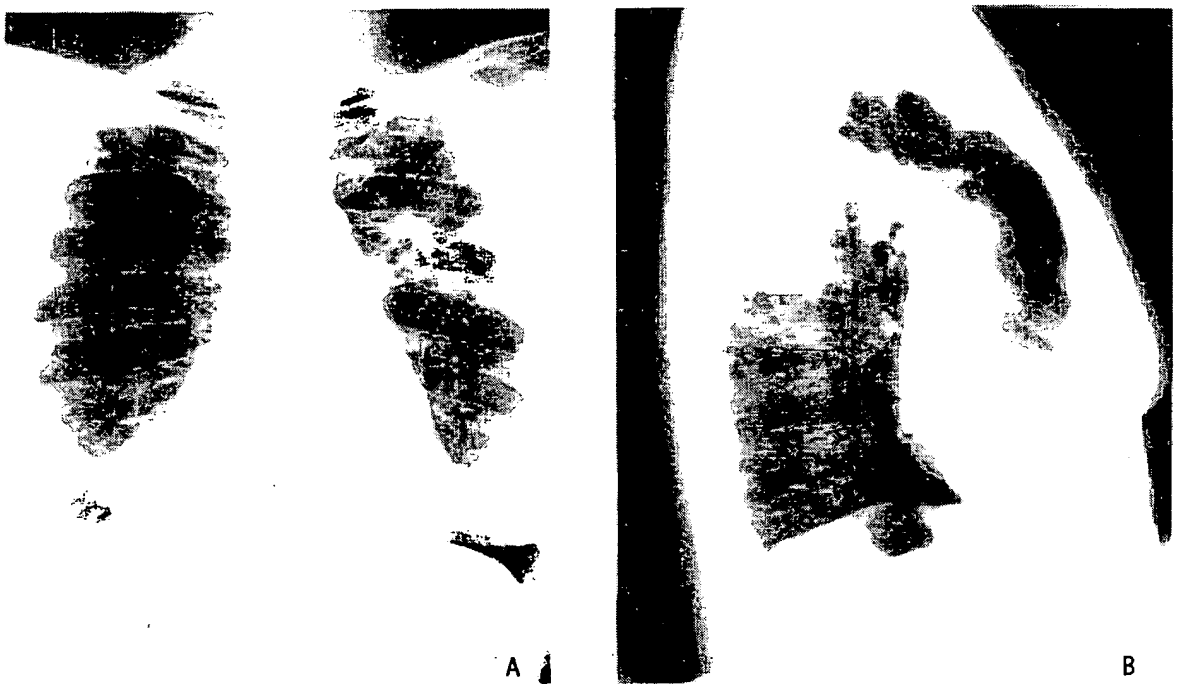

FIGURE 2. Case 1. (A and B) Post bilateral tube pneumonostomy posteroanterior and lateral chest x-ray films showing considerable increase of bronchovascular markings of both lungs.

She hardly coughed and had no expectoration. She was treated with bronchodilators, antibiotics, diuretics, and digoxin prior to my seeing her.

Smoking history. She started to smoke at the age of seventeen years and smoked at least two packs of cigarets daily. She stopped smoking a year before seeing us because of her marked dyspnea.

She was a thin, elderly woman, dyspneic at rest while dangling. She became markedly dyspneic when she attempted to talk or move her arms. Her lips and

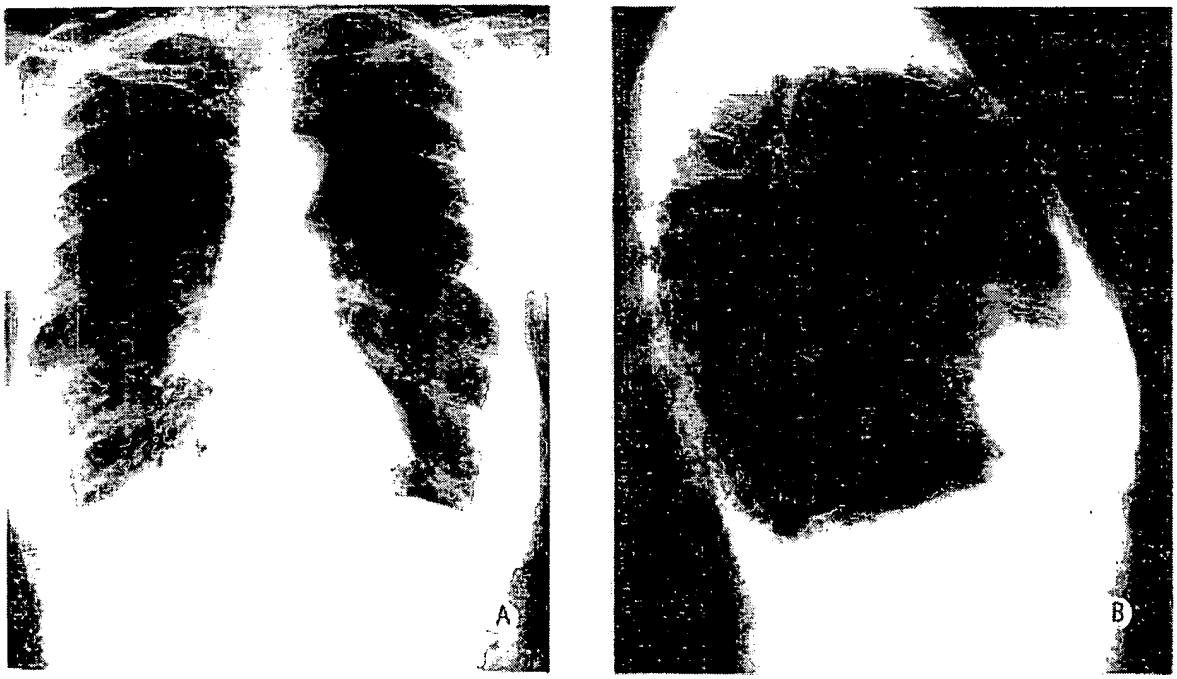

FIGURE 3. Case 2. (A and B) Preoperative posteroanterior and lateral chest roentgenograms showing overdistended lungs. Upper two thirds of both lungs occupied by large bullae.

TABLE IV. Case 2: Serial respiratory studies—26 SSTBD

Procedure and Dates of Studies	Vital Capacity (Ml.) Actual	Vital Capacity (Ml.) Per Cent	Timed Vital Capacity (Per Cent) 1 Sec.	2 Sec.	3 Sec.
Before therapy*	...	...	...	...	...
After therapy					
3/25/69	1,697	67	31	47	58
4/10/69	2,062	82	30	43	54
5/27/69	1,659	66	32	49	60
Two-staged right tube pneumonostomy					
5/29/69	...	...	...	...	...
6/8/69	...	...	...	...	...
7/22/69	1,725	66.5	37.5	53.5	65
Two-staged left tube pneumonostomy					
11/3/69	...	...	...	...	...
11/17/69	...	...	...	...	...
12/23/69	2,175	86	41	58	68

* Unable to endure studies.

TABLE V. Case 2: Serial respiratory studies—26 SSTBD*

Procedure and Dates of Study	MEFR L./Min.	MMEFR L./Sec.	MBC Act.	MBC Per Cent	TLC Act.	TLC Per Cent	RV Act.	RV Per Cent	RV/TLC Ratio
Before therapy†	...	...	...	...	...	...	...	...	...
After therapy									
3/25/69	16.7	0.16	14.5	24	6,091	167	4,394	391	72.1
4/10/69	22.8	0.17	15.2	25	6,496	178	4,299	382	66.2
5/27/69	15.4	0.14	12.3	19	5,922	162	4,263	379	72
Two-staged right tube pneumonostomy									
5/29/69	...	...	...	...	...	...	...	...	...
6/8/69	...	...	...	...	...	...	...	...	...
8/8/69	15.2	0.2	14.2	23	5,923	162	4,278	381	72.2
Two-staged left tube pneumonostomy									
11/3/69	...	...	...	...	...	...	...	...	...
11/17/69	...	...	...	...	...	...	...	...	...
12/23/69	31	0.211	11.8	18	5,449	149	3,273	291	60

* Key: MEFR = maximal expiratory flow rate; MMEFR = maximum mid-expiratory flow rate; Act. = actual; MBC = maximal breathing capacity; TLC = total lung capacity; RV = residual volume.
† Unable to endure studies.

TABLE VI. Case 2: Serial arterial blood gas studies—26 SSTBD*

Procedure and Dates of Studies	Arterial Blood Gas Studies pH	PAO_2 (Mm. Hg)	$PACO_2$ (Mm. Hg)
Before therapy			
3/18/69	7.49	32	45
After therapy			
3/27/69	7.45	56	36.5
5/27/69	7.42	55.1	51.1
Two-staged right tube pneumonostomy			
5/29/59	...	...	...
6/8/69	...	...	...
8/8/69	7.45	61	47.9
10/27/69	7.40	81	41
Two-staged left tube pneumonostomy			
11/3/69	...	...	...
11/17/69	...	...	...
12/23/69	7.46	90	37
3/16/70	7.385	71	39.5

* Key: PAO_2 = arterial oxygen pressure; $PACO_2$ = arterial carbon dioxide pressure.

nail beds were cyanotic. She had marked inspiratory retraction of her lower intercostal spaces. She had 2 plus pitting edema of her ankles. Auscultation revealed an almost silent chest. Heart sounds were distant. Her liver was 4 fingerbreadths below the costal margin. Roentgenograms of the chest showed overdistended lungs with the upper two-thirds of each lung showing bullae (Fig. 3). Respiratory studies confirmed the diagnosis of diffuse obstructive emphysema in addition to bullous emphysema (Tables IV to VI). The electrocardiogram showed evidence of right ventricular strain.

She could not endure the strain of respiratory studies until she underwent a series of three SSTBDs. After an additional eight SSTBDs her exercise tolerance increased, and she did not have heart failure any longer. The clinical improvement was also substantiated by follow-up respiratory studies (Tables IV to VI). After a total of sixteen SSTBDs the decision was made to perform bilateral tube pneumonostomies.

On May 29, 1969, she underwent right first-stage tube pneumonostomy. Ten days later, on June 8, she underwent right second-stage tube pneumonostomy. The pneumonostomy tube was attached to an underwater drainage setup. The latter was then attached to a suction unit. The suction was maintained for fourteen days before the pneumonostomy tube was removed on June 22, 1969. Her exercise tolerance increased noticeably. This was also substantiated by follow-up respiratory studies (Table IV to VI). On No-

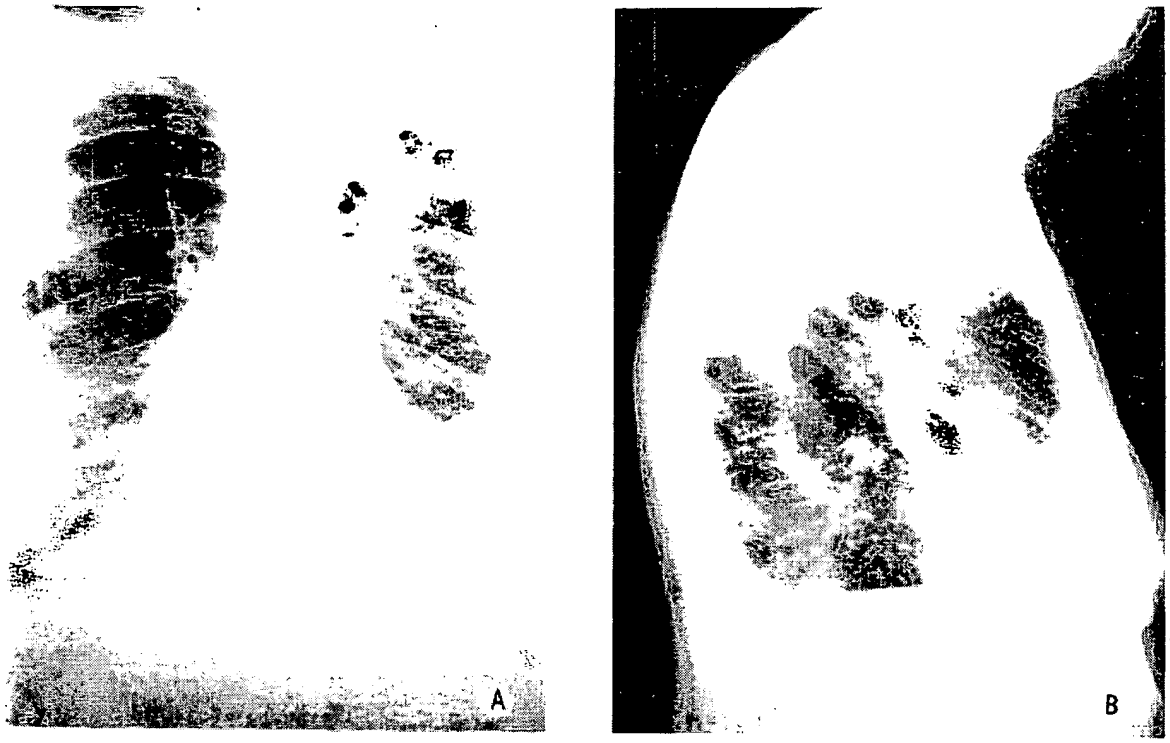

FIGURE 4. Case 2. (A and B) Post bilateral tube pneumonostomy posteroanterior and lateral chest x-ray films showing considerable increase of bronchovascular markings of both lungs.

vember 3, 1969, left first-stage tube pneumonostomy was done. Fourteen days later, on November 17, she underwent left second-stage tube pneumonostomy. The pneumonostomy tube was attached to an underwater drainage setup. The latter was then attached to a suction unit. The suction was maintained for seven days before the pneumonostomy tube was removed on November 24, 1969. X-ray films of the chest showed increased bronchovascular markings on both sides (Fig. 4). Her exercise tolerance increased strikingly. This previously totally disabled respiratory cripple was able to walk around the block and took care of her personal needs without exertional dyspnea. Accordingly, her follow-up respiratory and arterial blood gas studies showed appreciable changes for the better (Tables IV to VI). She was a most uncooperative patient who canceled appointments and rarely followed instructions. During the first week of August, 1970, she acquired an upper respiratory infection and went into failure of the right side of the heart. She did not ask for help until she became moribund. She died at home on August 13, 1970, the day she finally requested hospitalization.

This patient also showed striking increase of her exercise tolerance after bilateral tube pneumonostomies. The follow-up respiratory studies confirmed the clinical changes for the better. This woman could have been kept in her improved state had she allowed us to follow her closely.

Comment

Tube pneumonostomy is not a competing procedure for thoracotomy and resection or plication of the bullae in the treatment of disabling bullous emphysema. Tube pneumonostomy is the choice only if it is estimated that the patient could not survive a thoracotomy. In other words, it is to be performed only in thoracotomy-reject cases. The respiratory insufficiency in these crippling cases is usually due to both bullous emphysema and diffuse obstructive emphysema. Such are the 2 cases reported here. In both instances the choice was between abandoning these patients and tube pneumonostomies. The results of the physiologic studies substantiated the desperate clinical status of these respiratory cripples and made it clear that they had very little, if any, chance to survive thoracotomies (Tables I to VI). The patient in Case 2 was not even able to endure the exertion of respiratory studies until she was submitted to a series of three selective systematic tracheobronchial drainages. The selective systematic tracheobronchial drainages, and in 1 case tracheal fenestration, were aimed at increasing the respiratory capacity of the parts of the lungs with diffuse obstructive emphysema. This was achieved by elimination of often inspissated bronchial and bronchiolar mucus plugs, thus making available alveoli distal to the plugs. The nondestroyed, nonconfluent alveoli distal to the removed mucus plugs increase the respiratory surface (Tables I to VI). The real help in the reported cases came

from the deflation and elimination of the bullae. This is clearly demonstrated not only by the clinical course of these cases but also by the serial respiratory studies (Tables I to VI).

The procedure is effective because the insertion of the thoracotomy tube into the bulla with constant suction applied leads to deflation and bullous wall approximation. The approximated bullous wall became fused from seven to thirty-three days in the four tube pneumonostomies performed on these 2 patients. By eliminating the bullae, the surrounding, previously compressed lung parenchyma becomes aerated, again leading to usually marked increase of the respiratory capacity. I firmly believe it is justified to make a plea for the revival of tube pneumonostomy in the treatment of crippling thoracotomy-reject bullous emphysema. This simple procedure, when performed under local infiltration anesthesia, carries very little, if any, risk and provides a realistic renewed hope for rehabilitation of an otherwise abandoned group of respiratory cripples.

Summary

Tube pneumonostomy with constant suction, a procedure rarely used today, was revived. This procedure was performed bilaterally in 2 cases of thoracotomy-reject, crippling bullous emphysema. Both of these patients also had diffuse obstructive emphysema which made their condition too risky for thoracotomy and excision of the bullae. Serial respiratory studies substantiated the clinical improvement in both cases. The distinction between two different diseases, namely, bullous emphysema and diffuse obstructive emphysema, was emphasized. A plea was made for the application of tube pneumonostomy for crippling bullous emphysema rather than abandoning the patient when thoracotomy is contraindicated.

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Discussion

Dr. Fell: I believe that Dr. Rockey should be commended for again bringing to our attention some of the older technics which are extremely useful in salvaging poor-risk patients. One of the cases that he presented was a lung abscess, and I should like to present a case of lung abscess in which a similar technic was used except without tube drainage.

A seventy-year-old female after her second myocardial infarction required procainamide (Pronestyl) to control arrhythmias. This therapy led to the development of lupus erythematosus. The lupus persisted after the procainamide was withdrawn, and the patient was placed on steroids. While on steroids pneumonia developed in her right upper lobe which then cavitated into a huge abscess. When I first saw her she weighed 70 pounds, was febrile, and was in congestive failure. Under local anesthesia, I resected five ribs posteriorly and packed this huge abscess cavity. At the time the abscess was open I scooped a hairy ball which was, of course, aspergilloma. Roentgenography demonstrated the remarkable regenerative powers of the lung in decreasing the size of the cavity. Subsequently, the patient was left with a very small external opening of a bronchopleural cutaneous fistula. I was concerned that another aspergilloma would develop if we allowed this fistula to close. Accordingly, she was reoperated on and after partial scapulectomy the subscapularous muscle was utilized to close the bronchopleural fistula and obliterate the space. The patient is now cured. The interval between the two operations was approximately six months.

I should like to emphasize Dr. Rockey's point that we should not hesitate to use external drainage of pulmonary cavities in patients who are not salvageable by conventional methods.

Dr. Kirschner: Dr. Rockey has demonstrated that you can expand the lung by his intracavitary suction technic and thereby improve pulmonary function. However, I am not quite convinced that these patients have true "obstructive" emphysema along with their bullous emphysema. We can get the same functional result by open thoracotomy and excision of the bullae. The crux of the problem is the determination of the degree of compression of surrounding nonbullous lung tissue by the giant bulla. A patient who has a large bulla such as Dr. Rockey has shown, particularly bilateral with compressed lung in the lower medial portions of the chest, will experience substan-

tial functional improvement by excision of the bulla which allows the compressed lung to expand and function more normally.

The big problem in these patients with emphysema is in diffuse emphysema in which no large bullae exist. If you inadvertently operate without determining compression (best done by pulmonary angiography) and find the whole lung spongy, you will be in great trouble trying to improve pulmonary function. What you must have for a good surgical functional result is a very large bulla on both sides with marked compression. Once the compression is relieved, the so-called "obstructive" emphysema is markedly diminished as shown by Dr. Rockey's studies.

Dr. Robinson: In 1955 I used the technic that Dr. Rockey described on a patient with diffuse obstructive emphysema which involved the upper lobes of each side rather massively. I did this procedure on him bilaterally with a pre-Monaldi thoracoplasty on each side and multiple passages of a tube throughout the course of the lung because the obstruction was not relieved with the first drainage. A tube was passed through a trochar into many parts in the lung, and in a few days it was withdrawn as the lung collapsed around the tube. The patient went from a state of absolute total disability in which he could not eat, shave, or dress to one in which he led a comfortable sedentary life. I know this procedure works. I have never used it since, because I have never had any occasion to. I really congratulate Dr. Rockey for bringing it to us, because I know this method can work when used. In the case I cited thoracotomy and resection would not have been tolerated.

Voice: On the last patient you reported there was obvious expansion of one of the bulla in the late course of the disease. Did you try instillations of anything into the bulla to get it to stay closed once it was closed?

Dr. Rockey: I should like to thank the discussers for their remarks. Dr. Fell's operation was almost like a cavernostomy. The result certainly was satisfactory.

As to Dr. Kirschner's remarks, I should like to say that the physiologic data presented established the diagnosis of diffuse obstructive emphysema in addition to bilateral bullous emphysema in both cases. Thoracotomy and resection of the bullae was out of the question in these cases. This becomes obvious when you look again at the initial physiologic studies. One of the patients could not even withstand the strain of the respiratory studies until she was submitted to a series of three selective systematic tracheobronchial drainages. Tube pneumonostomies should be done only on patients who are estimated not to survive thoracotomies. Dr. Robinson used multiple-tube pneumonostomies for diffuse obstructive emphysema and helped his patient. This is of particular interest to me, since I often thought of trying to do just what he did but never had the courage to put a tube into a lung with diffuse obstructive emphysema. I believe this approach should be explored further.

I should like to reemphasize that tube pneumonostomy should be used whenever one encounters a thoracotomy-reject bullous emphysema rather than group that case with those for whom nothing can be done.

The Annual business meeting of the Society was held following the Scientific Session. The following slate took office for the coming year.

President ..... Joseph J. Timmes, M.D.
Vice-President ..... Walter A. Wichern, Jr., M.D.
Secretary-Treasurer ..... Richard B. Nolan, M.D.
Council ..... Adrian Lambert, M.D.
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Edward E. Rockey, M.D.
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Franklyn P. Gerard, M.D.
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..... Paul A. Kirschner, M.D., Chairman
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Robert T. Potter, M.D.
Editor of Proceedings .....
..... Allan Ellia Bloomberg, M.D.

The following associate members were advanced to active membership: Robert E. Madden, M.D., Herman R. Nayer, M.D., Martin E. Rose, M.D., Peter Hofstra, M.D., Walter Phillips, M.D., and Vincent Piccone, M.D.

The following were elected to associate membership: Julius W. Garvey, M.D., Alessandro A. d'Alessandro, M.D., Paul Kolker, M.D., and George E. Green, M.D.